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ABSTRACT

The summary information contained in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1997 administration of the Science 30 Diploma Examination by the Alberta Department of Education in Canada. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. Findings indicate that 90.8% of the 357 students who took the test achieved the acceptable standard and 8.4% of these students achieved the standard of excellence. Topics discussed include a description of the examination, achievement of standards, results and examiners' comments, multiple-choice and numerical-response questions, and written-response questions. (JRH)

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Science 30

Diploma Examination Results
Examiners' Report for January 1997

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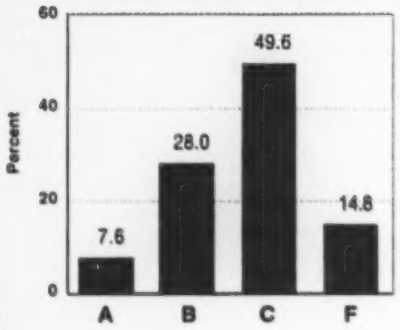
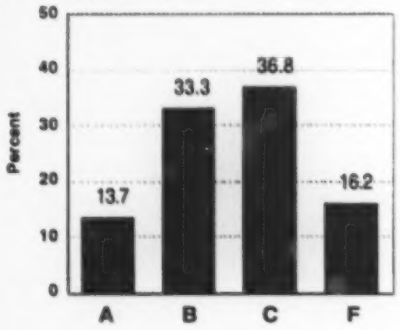
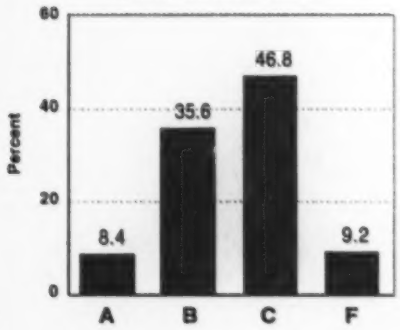
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1997 administration of the Science 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined January, June, and August results is made available annually.

Description of the Examination

The Science 30 Diploma Examination consists of 44 multiple-choice questions worth 55%, 12 numerical-response questions worth 15%, and 2 written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 357 students in Alberta who wrote the January 1997 examination.

- 90.8% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 8.4% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Students demonstrated a good understanding of the basic scientific method by correctly identifying the variables in an experiment and by interpreting and drawing graphs.

Students continue to experience difficulty balancing nuclear reactions and calculating the energy produced by nuclear reactions. Although they were successful with some multistep problems, the manipulation of more complex formulas remains a challenge.

Science 30 students continued to improve their communication skills. Their answers were generally well organized and all parts of the written-response questions were addressed. Responses could have been improved by greater use of specific examples to support ideas.

Approximately 47.3% of students who wrote the examination were females. Of these, about 79.9% achieved the acceptable standard on the examination, compared with 87.2% of the male population. Approximately 12.4% of the female population achieved the standard of excellence, compared with 14.9% of the male population. The average examination mark achieved by the female population was 61.7%, and the male population achieved an average mark of 65.6%.

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Provincial Averages

- The average school-awarded mark was 60.9%.
- The average diploma examination mark was 63.7%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 63.0%.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It is designed so that students achieving the acceptable standard will obtain a mark of 50% or higher, and students achieving the standard of excellence will obtain a mark of 80% or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer. For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, the "Difficulty" is the mean score achieved by students who wrote the examination.

Questions are also classified by general learner expectations. Even though some questions address more than one GLE, only one GLE was selected for the purpose of this report.

Knowledge:

- GLE 1 Nervous, Circulatory, & Immune Systems
- GLE 2 Genetics
- GLE 3 Chemistry & the Environment
- GLE 4 Gravitational, Electrical, & Magnetic Fields
- GLE 5 Astronomy & the Electromagnetic Spectrum
- GLE 6 The Production & Use of Energy

Skills:

- SPSC Scientific Process Skills and Communication Skills

Science, Technology, Society:

- STS Connections Among Science, Technology, & Society

Blueprint

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPSC	STS
MC1	D	0.580	√							√
NR1	1310	0.333					√		√	√
MC2	D	0.779			√					√
MC3	D	0.490						√		
NR2	3241	0.667					√		√	
NR3	1341/2/3	0.415					√		√	
NR4	1342	0.305					√			√
MC4	B	0.445			√					
MC5	C	0.359		√						
MC6	B	0.706			√					
MC7	C	0.459			√					√
MC8	A	0.591			√				√	
MC9	D	0.389			√				√	
NR5	1324	0.608			√					√
MC10	B	0.826			√					√
NR6	3421	0.630	√							
MC11	C	0.697	√							
MC12	D	0.639	√							
MC13	A	0.790					√			
MC14	C	0.683					√		√	√
NR7	3.25	0.863				√			√	√
MC15	C	0.754				√			√	√
MC16	C	0.218				√			√	√
MC17	B	0.529				√			√	√
MC18	C	0.896				√			√	√

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Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPSC	STS
MC19	A	0.849				√				
MC20	D	0.681				√				√
NR8	1.31	0.835					√		√	
MC21	D	0.650						√		√
MC22	C	0.602						√		
MC23	C	0.711						√		√
MC24	C	0.552			√				√	√
NR9	1234	0.636			√				√	
MC25	B	0.583			√				√	
MC26	B	0.697					√		√	
MC27	A	0.739			√					
MC28	C	0.283			√				√	
NR10	2341	0.580						√	√	√
MC29	C	0.849						√		√
MC30	B	0.574			√					√
MC31	A	0.594			√					√
MC32	D	0.630						√	√	√
MC33	C	0.485						√		
NR11	1.67/8/9	0.146						√	√	√
MC34	A	0.877						√		√
MC35	A	0.961	√						√	
MC36	B	0.922	√						√	
MC37	B	0.885	√							
MC38	C	0.669			√				√	√
MC39	C	0.700			√				√	
MC40	A	0.720			√					√
MC41	B	0.748						√	√	√
MC42	A	0.821					√			√
NR12	1324	0.818					√		√	
MC43	C	0.571		√						√
MC44	A	0.627		√					√	
WR1		0.682							√	√
WR2		0.565							√	√

Subtests

When analyzing detailed results, please bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 33.3 out of 56

General Learner Expectations

GLE 1	Nervous, Circulatory, & Immune Systems	5.3	out of	7
GLE 2	Genetics	1.6	out of	3
GLE 3	Chemistry & the Environment	10.9	out of	18
GLE 4	Gravitational, Electrical & Magnetic Fields	4.8	out of	7
GLE 5	Astronomy & the Electromagnetic Spectrum	6.4	out of	10
GLE 6	The Production & Use of Energy	6.7	out of	11
Skills		31.9	out of	51
STS		33.4	out of	51

Multiple choice: 28.8 out of 44

Numerical response: 6.8 out of 12

Written Response: 15.2 out of 24

Question 1: 8.18 out of 12

Question 2: 6.78 out of 12

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Use the following information to answer the next question.

A Reaction that Occurs in the Sun

$$ {}^{2}_{1}\mathrm{H} + {}^{2}_{A}\mathrm{H} \rightarrow {}^{B}_{2}\mathrm{He} + {}^{C}_{D}\mathrm{n} $$

Numerical Response

1. The use of sunscreens is recommended during daylight hours. The energy that causes skin to tan or burn is derived from nuclear reactions that occur in the Sun.

Record the numbers represented by the letters to correctly balance the above equation.

A is _____ (Record in column 1 on the answer sheet.)

B is _____ (Record in column 2 on the answer sheet.)

C is _____ (Record in column 3 on the answer sheet.)

D is _____ (Record in column 4 on the answer sheet.)

Answer: 1310

Numerical Response

11. One reaction that occurs within a CANDU reactor is

$$ {}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3\,{}^{1}_{0}\mathrm{n}. $$

The amount of energy released per mole of $ {}^{235}_{92}\mathrm{U} $ consumed is _____ . _____ _____ $\times 10^{X}$ J/mol.

(The masses of the reactants and products can be found in the data booklet.)

(Record your answer to **three** digits on the answer sheet)

Answer: 1.67, 1.68, or 1.69

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8. If the pH of the coral waters is 6.80, the hydronium ion concentration $[H_3O^+_{(aq)}]$ is

•**A.** 1.6×10^{-7} mol/L

B. 2.8×10^{-1} mol/L

C. 8.3×10^{-1} mol/L

D. 6.3×10^{6} mol/L

---

9. Some sources of acid rain may change the pH of rainwater from 6.1 to 4.1. This represents a hydronium ion concentration $[H_3O^+_{(aq)}]$ increase of

A. 2 times

B. 10 times

C. 20 times

•**D.** 100 times

Multiple-Choice and Numerical-Response Questions

Numerical-response question 1 required students to assign the correct subscripts (representing the number of protons) to the nuclear equation, apply the superscripts by using the data booklet to find the proper value for a neutron, and balance the masses of the products and reactants. A significant proportion of students (16.6%) assigned helium a mass of 4 instead of 3, a reasonable choice except that the resulting equation is not balanced.

Of all students who wrote the examination, 33.3% were able to properly assign numbers to the nuclear equation as were 53.1% of those achieving the standard of excellence, 34.0% of those achieving the acceptable standard but not the standard of excellence, and only 13.8% of those who did not achieve the acceptable standard.

Numerical-response question 11 required students to find the masses of the reactants and products in the data book, determine the mass loss, and apply the formula $E = mc^2$ to find the amount of energy released by the reaction. Some students (7.9%) found the mass loss for the reaction but failed to apply the energy formula to their answer.

Only 14.6% of students answered this question correctly, as did 32.7% of those who achieved the standard of excellence. Of students who achieved the acceptable standard but not the standard of excellence, 13.2% answered the question correctly, and only 5.2% of those who did not achieve the acceptable standard answered correctly.

Multiple-choice questions 8 and 9 provide a means of comparison of how well students performed on a routine calculation to determine the hydronium ion concentration from the pH with how well they performed on a question that demands a more in-depth understanding of the logarithmic nature of the pH scale.

On question 8, 18.8% of students chose D, indicating that they calculated the antilog of the pH rather than using the negative pH. These students were able to use the data booklet to find and apply the correct formula but likely had little time to practise with this particular type of question.

15. The boat contains an anchor that is raised by an electric winch. The electric winch draws 2.40 A supplied by a 48.0 V source. If it takes 3 min 35.0 s to raise the anchor, the amount of energy required is

A. 1.08×10^1 J

B. 1.15×10^2 J

•C. 2.48×10^4 J

D. 9.90×10^6 J

---

16. Two backup motors with resistances of 30 Ω and 15 Ω can be connected in parallel to operate the winch in the event of a failure of the winch motor. When connected in parallel, the total resistance of these motors is

A. 0.02 Ω

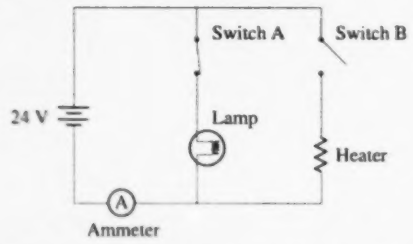
B. 0.10 Ω

•C. 10 Ω

D. 45 Ω

Use the following information to answer the next question.

Electricity to the wheelhouse of the boat is provided by a 24.0 V generator driven by a belt from the boat's engine. The wheelhouse circuit contains a 60.0 W lamp and an electrical outlet into which a 600 W heater can be plugged. The wiring of the wheelhouse is illustrated below.



17. When switch A is closed and switch B is open, the reading on the ammeter is

A. 0.400 A

•B. 2.50 A

C. 25.0 A

D. 27.5 A

On question 9, students who chose C (34%) indicated that they realized a change in pH has a multiplying effect on the hydronium ion concentration and that each step on the pH scale produces a change in the hydronium ion concentration by a factor of 10. Of all students, 59.1% answered question 8 correctly, as did 79.6% of those who achieved the standard of excellence, 59.6% of those who achieved the acceptable standard but not the standard of excellence, and 39.7% of those who did not achieve the acceptable standard. Of all students, only 38.9% answered question 9 correctly, as did 69.4% of those who achieved the standard of excellence, 39.6% of those who achieved the acceptable standard but not the standard of excellence, and only 10.3% of those who did not achieve the acceptable standard.

Multiple-choice questions 15, 16, 17, and 18 provide an opportunity to analyze how well students understand the concepts related to electricity.

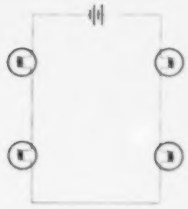
Questions 15 is a two-step calculation that requires the student to convert time to seconds, then apply the appropriate formula to calculate the amount of energy required for a winch to lift an anchor. By choosing B for question 15, 16.6% of the students indicated that they were aware that it was necessary to find the amount of power being used. These students neglected to multiply by time in order to determine the amount of energy consumed by the winch.

For question 15, 75.4% of all students who wrote the exam, 91.8% of those who achieved the standard of excellence , 76.0% of those who achieved the acceptable standard but not the standard of excellence, and 58.6% of those who did not achieve the acceptable standard answered correctly.

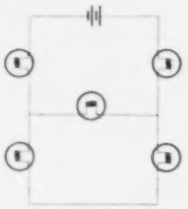
Although question 16 requires the application of only one formula, students found it much more difficult than question 15. Many of the students (39.7%) treated the problem as if the resistances were connected in series and simply added them. It was mainly students who scored low on the total exam who chose this option. Many higher-scoring students chose B, indicating that they were using the correct formula for resistances connected in parallel. However, many of these students were unable to solve the equation.

18. The deck lights are wired so that if any light burns out, the other lights still operate. A diagram that represents this circuit is

A.

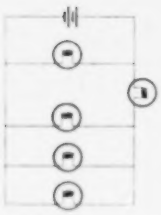


B.



•C.

D.



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44. One genetic mutation that has been passed along for generations causes cystic fibrosis. The gene that causes the disease is recessive to the normal gene. The chance that a child from two heterozygous parents (carriers) will inherit the disease is

•A. 25%

B. 50%

C. 75%

D. 100%

For question 16, only 21.8% of all students who wrote the exam, 44.9% of those who achieved the standard of excellence, 18.8% of those who achieved the acceptable standard but not the standard of excellence, and 15.5% of those who did not achieve the acceptable standard answered correctly.

Question 17 required students to interpret a circuit diagram and use the appropriate information from a context to find the current in a circuit. Students found this challenging; only 52.9% answered correctly. Of students who achieved the standard of excellence, 71.4% answered correctly. Of the students who achieved the acceptable standard but not the standard of excellence, 52.4% answered the question correctly, as did 39.7% of those who did not achieve the acceptable standard.

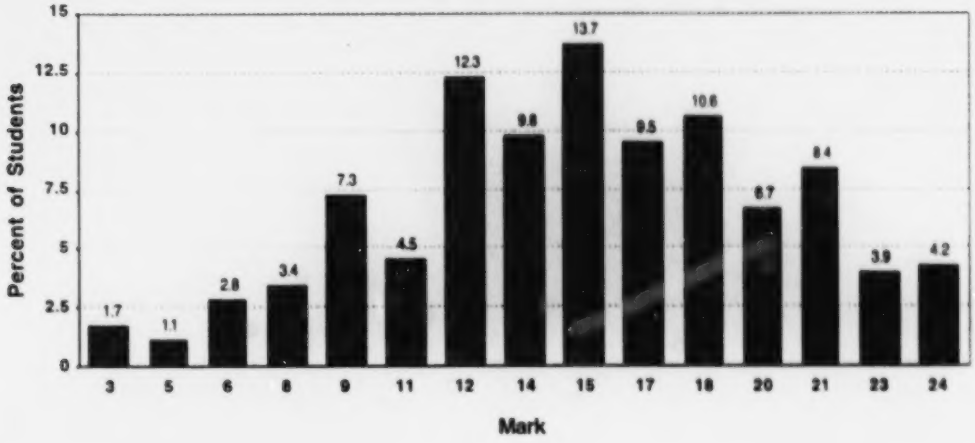
Question 18 was answered correctly by 89.6% of the students. Students clearly understand the concept of a complete circuit and the use of parallel connections.

Multiple-choice question 44 is a routine Mendelian genetics question. For this question, 62.7% of all students who wrote the exam, 89.8% of those who achieved the standard of excellence, 63.2% of those who achieved the acceptable standard but not the standard of excellence, and 37.9% of those who did not achieve the acceptable standard answered correctly.

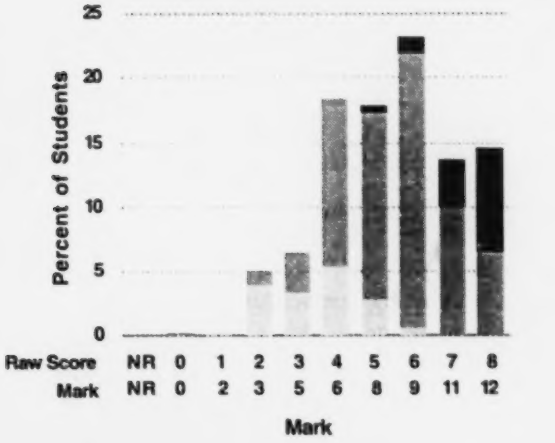
Written-Response Questions

Performance on written-response questions has improved steadily since the beginning of field testing in January 1994, where a large portion of students did not even attempt to answer the written-response questions. Of the students who wrote this examination, no student received no mark for both written-response questions, 79.3% received 12 marks or more out of 24, and 23.2% received 20 marks or more out of 24. The average mark on the written-response questions was 15.16 out of 24 or 63.2%.

Distribution of Marks for Written Response



Distribution of Marks for Question 1



Standard of Excellence on the Examination

Acceptable but not Standard of Excellence on the Examination

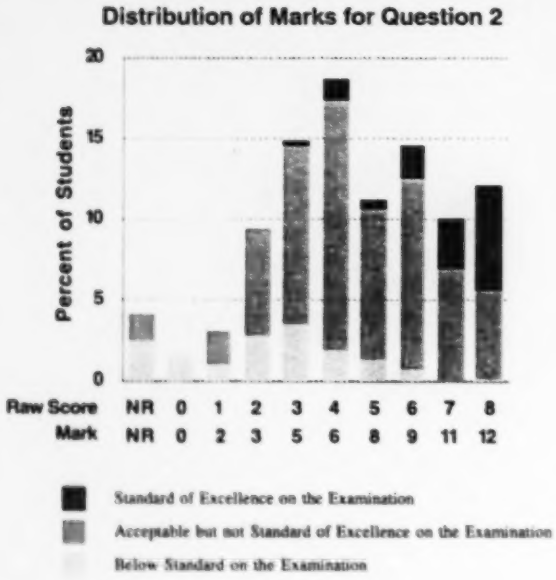
Below Standard on the Examination

Question 1: This process-skill question, which involved graphing the cost of energy production and outlining the role of wind power, was attempted by all of the students who wrote the examination.

Part *a* and *b* required students to fill in a table and design a graph for the cost of producing electricity by three different means. Almost all of the students who wrote the examination had no difficulty in accomplishing this part of the question. A few students used a line graph where a bar graph would have been more appropriate.

In part *c*, most students gave a reasonable risk/benefit analysis of coal-burning power plants. Most could have improved their answers by including specific examples rather than generalities. For example, instead of stating that coal-burning plants produce pollution, they might have mentioned that $SO_{2(g)}$ is produced by burning coal and that this gas produces acid deposition when it reacts with moisture in the air.

On this 12-mark question, the average was 8.18 or 68.2%. On this question, 88.0% of the student population achieved the acceptable standard, and 23.3% achieved the standard of excellence.


Distribution of Marks for Question 2
Percent of Students
20
15
10
5
0
Raw Score NR 0 1 2 3 4 5 6 7 8
Mark NR 0 2 3 5 6 8 9 11 12
Standard of Excellence on the Examination
Acceptable but not Standard of Excellence on the Examination
Below Standard on the Examination

Question 2: This question was attempted by all but 15 students. Most students were able to provide a general description of a disease and its mode of operation. A few students were able to give a detailed description of how the disease affects the systems of the body and some students provided an explanation of the technology currently being developed to treat the disease or disorder. Most of the responses could have been improved by the use of specific examples of research or technology.

On this 12-mark question, the average mark was 6.78 or 56.5%. On this question, 66.7% of the student population achieved the acceptable standard, and 22.1% of the student population achieved the standard of excellence.

For further information, contact John Drader (jdrader@edc.gov.ab.ca) or Phill Campbell (pcampbell@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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